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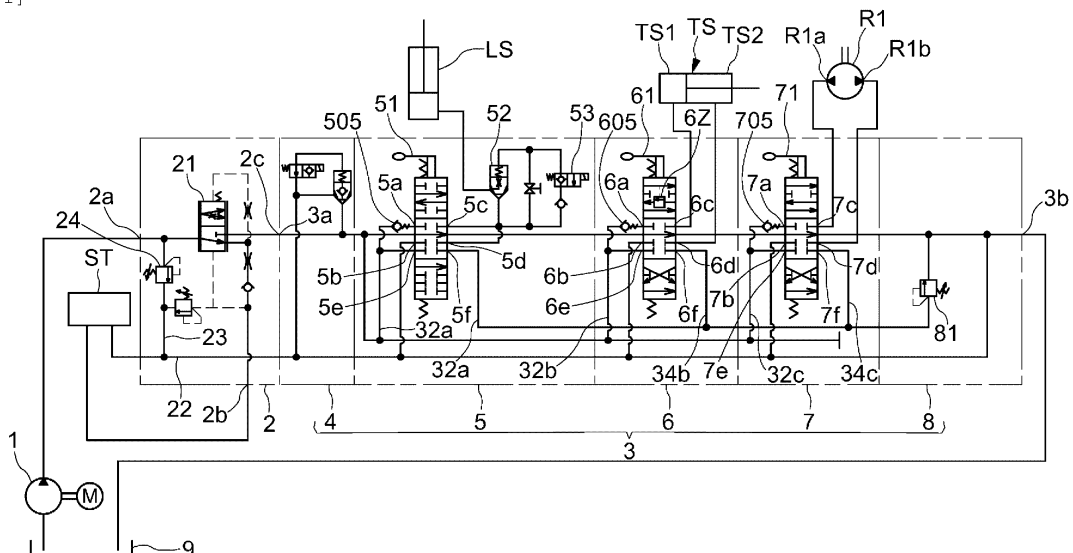
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(54) **FLUID CONTROL DEVICE**

(57) A fluid control device provided with a plurality of switching valves and a plurality of relief valves, wherein a sub-relief passage communicating with a tank when the switching valves are in any state other than neutral is branched from a parallel passage for guiding a high-pressure hydraulic fluid to the switching valves, a sub-relief valve is provided within the sub-relief passage, and a check valve that minimizes the flow of hydraulic fluid toward a hydraulic pressure supply source is provided between switching valves and the point of branch-

ing of the sub-relief passage in the parallel passage, whereby the number of components and man-hours for assembly can be reduced due to the sub-relief passage having no check valve, hydraulic fluid can be prevented from heading toward a pump from an actuator even when the plurality of switching valves are operated simultaneously, and with no need for high hydraulic fluid pressure, high-pressure hydraulic fluid is prevented from being guided to an actuator having comparatively low pressure-resistant performance.

[FIG. 1]



## Description

### Technical Field

**[0001]** The present invention relates to a fluid control device that is used in industrial vehicles or industrial machines and is equipped with a plurality of switching valves and a plurality of relief valves.

### Background Art

**[0002]** From related art, in industrial vehicles and the like, a fluid control device equipped with a plurality of switching valves has been known. This device is used by connecting an actuator to each switching valve, respectively. As an actuator connected to the switching valve of such a fluid control device, for example, a lift cylinder for raising and lowering a loading platform in a forklift or a tilt cylinder for inclining a mast supporting the loading platform forward and backward is adopted.

**[0003]** Incidentally, in such a fluid control device, in some cases, hydraulic fluid pressures necessary for operating each actuator may be different from each other. In other words, the hydraulic fluid pressure necessary for raising the loading platform, the hydraulic fluid pressure necessary for inclining the mast forward or backward, and the hydraulic fluid pressure necessary for an actuator for an attachment such as a clamping function which is a case of being added separately are different from each other. From this, it is conceivable to provide a plurality of relief valves, such as providing the relief valves at each cylinder port. Specifically, it is conceivable to provide a main-relief valve for preventing the hydraulic fluid pressure in a passage for supplying the hydraulic fluid from a fluid pressure supply source to each actuator from exceeding a predetermined first fluid pressure which is a highest fluid pressure, and it is conceivable to provide a sub-relief valve for preventing the hydraulic fluid pressure supplied to an actuator for other tilt or attachment from exceeding a second fluid pressure lower than the first fluid pressure, with respect to an actuator such as a lift cylinder requiring the highest hydraulic fluid pressure. When such a configuration is adopted, an actuator which does not require a high hydraulic fluid pressure and a pipe associated with the actuator are protected. In addition, by adopting the actuator and the pipe having relatively low pressure resistance performance, it is possible to reduce the cost. Installing examples of the sub-relief valve are as follows (see, for example, Patent Documents 1 and 2).

**[0004]** In Patent Document 1, when the switching valve connected to the lift cylinder, which is an actuator requiring the highest hydraulic fluid pressure, takes a position other than a raised position to direct the hydraulic fluid to the lift cylinder, the hydraulic fluid from the hydraulic pressure supply source is directed to the sub-relief valve. However, when this configuration is adopted, the following problems may occur. That is, when another actuator

is operated in a state in which the lift cylinder is located at the raised position, since the hydraulic fluid is not directed to the sub-relief valve, the hydraulic fluid at a higher pressure than the second fluid pressure may be directed to the another actuator. At this time, another actuator or the pipe associated with the actuator may be broken unless devices capable of withstanding the highest pressure are selected. On the other hand, when another actuator or the pipe is made to withstand the high pressure, although it is possible to prevent breakage, another problem arises in which it is not possible to achieve the cost reduction as described in the preceding paragraph.

**[0005]** In Patent Document 2, when a switching valve connected to a member other than the lift cylinder takes a position for operating the actuator, that is, a position other than a neutral position, the hydraulic fluid from the hydraulic pressure supply source is directed to a sub-relief passage including a sub-relief valve, other than the actuator. The sub-relief passage branches inside the switching valve. When such a configuration is adopted, even in a case where the lift cylinder is located at the raised position, the sub-relief valve operates when the hydraulic fluid pressure directed to another actuator exceeds the second fluid pressure. Thus, the problem described in the previous paragraph is solved. However, when adopting such a configuration, in order to prevent the occurrence of problems due to the fact that the actuators communicate with each other inside the switching valve and via the sub-relief passage in a case where the plurality of switching valves simultaneously take the positions other than the neutral position, it is necessary to separately provide a check valve in the sub-relief passage. Therefore, there is another problem of increases in the number of components and assembling man-hours.

### Citation List

Patent Document

### [0006]

Patent Document 1: US-A-4561463

Patent Document 2: JP-A-2007-239992

### Summary of the Invention

### Technical Problem

**[0007]** The present invention has been made under such a circumstance, and an object thereof is to prevent a high-pressure hydraulic fluid from being directed to an actuator which does not require a high hydraulic fluid pressure and has relatively low pressure resistance performance, without causing an increase in the number of components and assembling man-hours.

## Solution to Problem

**[0008]** In order to solve the above problems, a fluid control device according to the present invention has the following configuration. That is, the fluid control device according to the present invention includes a plurality of switching valves; a high-pressure flow path which receives supply of high-pressure hydraulic fluid from a hydraulic pressure supply source, and passes through the plurality of switching valves in a neutral state; a parallel flow path which branches from the high-pressure flow path to direct the hydraulic fluid to each of the switching valves; a return flow path which receives and directs the hydraulic fluid having passed through all the switching valves via the high-pressure flow path and the hydraulic fluid discharged from each switching valve to a tank; a main-relief passage through which a part between the hydraulic pressure supply source and the switching valve located on a most upstream side communicates with the return flow path; a main-relief valve which is provided in the main-relief passage and opens when the fluid pressure of the high-pressure flow path exceeds a predetermined first fluid pressure; a sub-relief passage which branches from the parallel passage, reaches the switching valve, and communicates with the tank when the switching valve is in a predetermined state other than the neutral state; a sub-relief valve which is provided in the sub-relief passage, and opens when the fluid pressure of the parallel flow path exceeds a second fluid pressure lower than the first fluid pressure; and a check valve which suppresses the flow of hydraulic fluid toward a hydraulic pressure supply source provided between the branch with the sub-relief passage and the switching valve in the parallel passage.

**[0009]** In such a case, since the sub-relief passage branches off from the parallel passage, the sub-relief passage and the passage reaching the actuator from the switching valve do not communicate with each other inside the switching valve. Further, even when a plurality of actuators is operated at the same time, it is possible to prevent the hydraulic fluid in a certain actuator from flowing out to another actuator via the parallel passage and the sub-relief passage, by the check valve in the parallel flow path. Accordingly, there is no need to separately provide a check valve in the sub-relief passage, and the number of components can be reduced.

## Advantageous Effects of the Invention

**[0010]** According to the present invention, it is possible to prevent a high-pressure hydraulic fluid from being directed to an actuator which does not require a high hydraulic fluid pressure and has relatively low pressure resistance performance, without causing an increase in the number of components and assembling man-hours.

## Brief Description of the Drawings

**[0011]**

5 Fig. 1 is a diagram illustrating a fluid control device according to an embodiment of the present invention.

Fig. 2 is a diagram schematically illustrating a switching valve according to the same embodiment.

10 Fig. 3 is an operation explanatory view according to the same embodiment.

Fig. 4 is an operation explanatory view according to the same embodiment.

## 15 Mode for Carrying Out the Invention

**[0012]** An embodiment of the present invention will be described below with reference to Figs. 1 to 4.

**[0013]** A fluid control device C according to the present embodiment includes a tank 9 for storing a hydraulic fluid, a hydraulic pump 1 which sends the hydraulic fluid from the tank 9, a priority valve mechanism 2 which receives the supply of the hydraulic fluid from the hydraulic pump 1, and a fluid pressure unit 3 which is stacked on the priority valve mechanism 2. The fluid pressure unit 3 has a pump side port 3a which receives the supply of hydraulic fluid from a surplus flow output port 2a of the priority valve mechanism 2, and a tank side port 3b which discharges the hydraulic fluid.

**[0014]** The priority valve mechanism 2 is used for a forklift or the like, and has the same configuration as a mechanism which is known as this type of priority valve mechanism which supplies the hydraulic fluid to a steering mechanism, and a fluid pressure unit formed by stacking a plurality of switching valves. That is, various valves such as the priority valve main body 21 are integrally incorporated in the interior, a priority diversion function of dividing the supplied hydraulic fluid into a priority flow and a surplus flow. The priority valve mechanism 2 includes an introduction port 2a, a discharge port 2b, and a surplus flow output port 2c. The introduction port 2a is an introduction port of the high-pressure hydraulic fluid discharged from the hydraulic pump 1. The discharge port 2b communicates with a steering operation assisting circuit ST, and preferentially discharges the hydraulic fluid necessary when performing the steering operation. The surplus flow output port 2c discharges the surplus hydraulic fluid. Further, the priority valve mechanism 2 includes a return flow path 22, a main-relief passage 23, and a main-relief valve 24. The hydraulic fluid discharged from the steering operation assisting circuit ST passes through the return flow path 22. The main-relief passage 23 short-circuits the introduction port P and the return flow path 22. The main-relief valve 24 is provided in the main-relief passage 23 to prevent the pressure of the hydraulic fluid introduced into the introduction port P from exceeding a predetermined first fluid pressure.

**[0015]** The fluid pressure unit 3 includes a combination

of an unloading valve 4, first, second, and third fluid control valves 5, 6, and 7, and a sub-relief valve section 8 equipped with a sub-relief valve 81. Further, the fluid pressure unit 3 further has a high-pressure flow path 31, first to third parallel flow paths 32a to 32c, a return flow path 33, and first to third sub-relief passages 34a to 34c therein. The high-pressure flow path 31 receives the hydraulic fluid supplied from the pump side port 3a. The first to third parallel flow paths 32a to 32c branch from the high-pressure flow path 31 to supply the hydraulic fluid to the first to third fluid control valves 5 to 7. The return flow path 33 is in communication with the return flow path 22 of the priority valve mechanism 2 and receives the hydraulic fluid having passed through the third fluid control valve 7 via the high-pressure flow path 31 and the hydraulic fluid discharged from the first to third fluid control valves 5 to 7. The first to third sub-relief passages 34a to 34c are connected to the return flow path 33 from the parallel flow path 32 via the first to third fluid control valves 5 to 7. Each of the first to third fluid control valves 5 to 7 functions as the switching valve of the present invention.

**[0016]** The first parallel flow path 32a branches from the high-pressure flow path 31 and is connected to the first fluid control valve 5. Further, a check valve 505 which suppresses the flow of the hydraulic fluid from the first fluid control valve 5 toward the pump is provided in the first parallel flow path 32a.

**[0017]** The second parallel flow path 32b branches from the first parallel flow path 32a and is connected to the second fluid control valve 6. Further, a check valve 605 which suppresses the flow of the hydraulic fluid from the second fluid control valve 6 toward the pump is provided in the second parallel flow path 32b.

**[0018]** Further, the third parallel flow path 32c branches from the second parallel flow path 32b, and is connected to the third fluid control valve 7. Further, a check valve 705 which suppresses the flow of the hydraulic fluid from the third fluid control valve 7 toward the pump is provided in the third parallel flow path 32c.

**[0019]** The first sub-relief passage 34a branches from the upstream side of the check valve 50 in the first parallel passage 32a, and joins the return flow path 33 via the first fluid control valve 5 and the sub-relief valve 81. However, an upstream side and a downstream side of the first fluid control valve 5 in the first sub-relief passage 34a are always closed by the first fluid control valve 5.

**[0020]** The second sub-relief passage 34b branches from the upstream side of the check valve 60 in the second parallel passage 32b, joins the first sub-relief passage 34a via the second fluid control valve 6, and joins the return flow path 33 via the sub-relief valve 81.

**[0021]** The second sub-relief passage 34c branches from the upstream side of the check valve 70 in the third parallel passage 32c, joins the second sub-relief passage 34b via the third fluid control valve 7, and joins the return flow path 33 via the sub-relief valve 81.

**[0022]** The sub-relief valve 81 opens when the hydrau-

lic fluid pressure supplied from the parallel flow path 32 to the second and third fluid control valves 6 and 7 exceeds the second fluid pressure. The second fluid pressure is lower than the first fluid pressure which is the fluid pressure of the threshold value at which the main-relief valve 24 opens.

**[0023]** The unloading valve 4 is connected to, for example, a seating sensor (not illustrated), and only when the seating sensor does not detect that an operator is seated on the driver's seat, the high-pressure flow path 31 is made to communicate with the return flow path 33.

**[0024]** The first fluid control valve 5 has an inflow port 5a connected to the parallel flow path 32, a discharge port 5b connected to the return flow path 33, and first and second output ports 5c and 5d connected to a lift cylinder LS serving as an actuator. Further, the first fluid control valve 5 can selectively take three positions of a neutral position, a rising position, and a lowered position. The neutral position causes the high-pressure flow path 31 to communicate with the return flow path 33. The rising position causes the inflow port 5a and the first output port 5a to communicate with each other. The lowered position causes the discharge port 5b and the second output port 5d to communicate with each other and causes the high-pressure flow path 31 to communicate with the return flow path 33. The first fluid control valve 5 is connected to a first operation lever 51 to receive an operation on the first operation lever 51 and perform switching among the three positions. Further, a logic valve 52 is provided between the first output port 5c and the lift cylinder LS. An electromagnetic valve 53 is provided in a back pressure chamber of the logic valve 52, and the lift cylinder LS is prevented from descending due to the backward flow of the hydraulic fluid from the lift cylinder LS, by the operation of the electromagnetic valve 53. As described above, the lift cylinder LS is connected to the first fluid control valve 5 via the first and second output ports 5c and 5d, and receives the supply of the hydraulic fluid to raise a fork (not illustrated) connected to the lift cylinder LS. Further, the lift cylinder LS discharges the hydraulic fluid to lower the fork (not illustrated) connected to the lift cylinder LS. Further, the first fluid control valve 5 has a pilot port 5e connected to the upstream side of the first sub-relief passage 34a, and a relief port 5f connected to the downstream side of the first sub-relief passage 34a. However, the pilot port 5e and the relief port 5f are always disconnected from each other.

**[0025]** The second fluid control valve 6 has an inflow port 6a connected to the parallel flow path 32, a discharge port 6b connected to the return flow path 33, a first output port 6c connected to a cylinder chamber TS1 side of a tilt cylinder TS which is an actuator, a second output port 6d connected to a piston TS2 side of the tilt cylinder TS, a pilot port 6e connected to the upstream side of the second sub-relief passage 34b, and a relief port 6f connected to the downstream side of the second sub-relief passage 34b. Further, the second fluid control valve 6 can selectively take a neutral position, an inclined posi-

tion, and an upright position. The neutral position causes the high-pressure flow path 31 to communicate. The inclined position causes the inflow port 6a and the first output port 6c to communicate with each other, and causes the discharge port 6b and the second output port 6d to communicate with each other. The upright position causes the inflow port 6a and the second output port 6d to communicate with each other, and causes the discharge port 6b and the first output port 6c to communicate with each other. Here, at the neutral position, the pilot port 6e and the relief port 6f are disconnected from each other. On the other hand, at the inclined position and the upright position, the pilot port 6e communicates with the relief port 6f, and a part of the high-pressure hydraulic fluid from the second parallel flow path 32b is directed to the second sub-relief passage 34b. The second fluid control valve 6 is connected to a second operation lever 61, and receives an operation on the second operation lever 61 to perform switching among the aforementioned three positions. Further, in order to prevent the mast from being inclined forward due to the backward flow of the hydraulic fluid when the mast (not illustrated) supporting the fork is stopped in the forward inclined posture, the second fluid control valve 6 is provided with a tilt lock valve 6Z. The tilt cylinder TS includes a cylinder chamber TS1 and a piston TS2. As described above, the cylinder chamber TS1 communicates with the first output port 6c of the second fluid control valve, and the piston TS2 side communicates with the second output port 6d of the second fluid control valve. Further, the supply of hydraulic fluid is received by the cylinder chamber TS1 side, and the mast (not illustrated) which is connected to the tilt cylinder TS and supports the fork (not illustrated) is inclined forward. On the other hand, when the supply of hydraulic fluid is received by the piston TS2 side, the mast (not illustrated) is returned from the forward inclined state to the upright state.

**[0026]** The third fluid control valve 7 has an inflow port 7a connected to the parallel flow path 32, a discharge port 7b connected to the return flow path 33, a first output port 7c connected to a first fluid introduction port R1a of a rotary mechanism R which is an actuator, a second output port 7d connected to a second fluid introduction port R1b of the rotary mechanism R, a pilot port 7e connected to the upstream side of the third sub-relief passage 34c provided to branch from the parallel flow path 32, and a relief port 7f connected to the downstream side of the third sub-relief passage 34c. Further, the third fluid control valve 7 can selectively take three positions of a neutral position, a positive rotation position, and a reverse rotation position. The neutral position causes the high-pressure flow path 31 to communicate. The positive rotation position causes the inflow port 7a and the first output port 7c to communicate with each other, and causes the discharge port 7b and the second output port 7d to communicate with each other. The reverse rotation position causes the inflow port 7a and the second output port 7d to communicate with each other, and causes the

discharge port 7b and the first output port 7c to communicate with each other. Here, at the neutral position, the pilot port 7e and the relief port 7f are disconnected from each other. On the other hand, at the positive rotation position and the reverse rotation position, the pilot port 7e communicates with the relief port 7f, and a part of the high-pressure hydraulic fluid from the third parallel flow path 32c is directed to the third sub-relief passage 34c. Further, the third fluid control valve 7 is connected to a third operation lever 71, and receives an operation on the third operation lever 71 to perform the switching among the three positions. The rotary mechanism R is configured by utilizing a hydraulic motor R1 having first and second fluid introduction ports R1a and R1b, and drives a rotary attachment (not illustrated) such as a rotary fork connected to the hydraulic motor R1 via an output shaft. Specifically, the rotary mechanism R has a configuration which receives the supply of the hydraulic fluid from the first fluid introduction port R1a, rotates the rotation attachment in the positive direction to discharge the hydraulic fluid from the second fluid introduction port R1b, receives the supply of hydraulic fluid from the second fluid introduction port R1b, and rotates the rotary attachment in the positive direction to discharge the hydraulic fluid from the first fluid introduction port R1a. That is, a rotary attachment such as a rotary fork driven by the rotary mechanism R can rotate in both positive and reverse directions.

**[0027]** Both the second and third fluid control valves 6 and 7 have the following configuration. Here, since the second fluid control valve 6 and the third fluid control valve 7 have the same configuration, the configuration of the second fluid control valve 6 will be described as a representative.

**[0028]** As illustrated in Fig. 2, the second fluid control valve 6 includes a body 600, and a spool valve body 604 capable of sliding in a spool hole 602 provided in the body 600. In the body 600, a hydraulic fluid supply path 601 constituting the second parallel flow path 32b, a center passage 603 constituting a high-pressure flow path 31, the check valve 605 provided in the hydraulic fluid supply path 601, the first output port 6c, the second output port 6d, the discharge port 6b, the pilot port 6e, and the relief port 6f are formed. Further, the downstream side of the check valve 605 in the hydraulic fluid supply path 601 is formed as an arch section 606 having a function as the inflow port 6a.

**[0029]** The spool valve body 604 is provided with a first communication groove 604a, a second communication groove 604b, a third communication groove 604c, and a fourth communication groove 604d. The first communication groove 604a causes the arch section 606 and the first output port 6c to communicate with each other at the inclined position, and causes the arch section 606 and the discharge port 6b to communicate with each other at the upright position. The second communication groove 604b causes the arch section 606 and the discharge port 6b to communicate with each other at the inclined posi-

tion, and causes the arch section 606 and the second output port 6d to communicate with each other at the upright position. The third communication groove 604c causes the pilot port 6e and the relief port 6f to communicate with each other at the inclined position. The fourth communication groove 604d causes the pilot port 6e and the relief port 6f to communicate with each other at the upright position.

**[0030]** On the other hand, in the body 600, a first land 600a is provided between the arch section 606 and the first output port 6c, a second land 600b is provided between the arch section 606 and the second output port 6d, a third land 600c is provided between the first output port 6c and the discharge port 6b, a fourth land 600d is provided between the second output port 6d and the discharge port 6b, and a fifth land 600e is provided between the pilot port 6e and the relief port 6f. These first to fifth lands 600a to 600e have a function of blocking the ports via parts other than the communication grooves 604a to 604d of the spool valve body 604.

**[0031]** Further, although it is not illustrated, members such as a pilot spool constituting a tilt lock valve 6Z, and a spring for urging the pilot spool toward the valve closing position are disposed inside the spool valve body 604. Since the configuration and operation of the tilt lock valve 6Z have the same configuration as that well known as a tilt lock valve used for this type of fluid control valve, a detailed description thereof will not be provided.

**[0032]** Here, in a state in which the second fluid control valve 6 is disposed at the neutral position, as illustrated in Fig. 2, the arch section 606 and the first output port 6c are disconnected from each other, and the arch section 606 and the second output port 6d are disconnected from each other. Further, the hydraulic fluid supply path 601, the pilot port 6e, and the relief port 6f are also disconnected from one another.

**[0033]** On the other hand, in a state in which the second fluid control valve 6 is disposed at the inclined position, as illustrated in Fig. 3, the arch section 606 and the first output port 6c communicate with each other, the second output port 6d and the discharge port 6b communicate with each other, respectively. Also, the hydraulic fluid supply path 601, the pilot port 6e, and the relief port 6f also communicate with one another. As a result, a part of the hydraulic fluid supplied from the pump to the second parallel flow path 32b is directed to the first output port 6c, and the other part of the hydraulic fluid is directed to the sub-relief valve 81 via the relief port 6f. Further, when the fluid pressure of the hydraulic fluid supplied to the second parallel flow path 32b exceeds the second fluid pressure, even in a case where the fluid pressure of the hydraulic fluid is lower than the first fluid pressure, the sub-relief valve 81 opens and the hydraulic fluid is directed to the tank 9 via the return passage 33.

**[0034]** Further, in the state in which the second fluid control valve 6 is disposed at the upright position, as illustrated in Fig. 4, the arch section 606 and the second output port 6d communicate with each other, and the first

output port 6c and the discharge port 6b communicate with each other, respectively. Further, similarly to the state in which the second fluid control valve 6 is disposed in the inclined position, the hydraulic fluid supply path 601, the pilot port 6e, and the relief port 6f also communicate with one another. As a result, a part of the hydraulic fluid supplied from the pump to the second parallel flow path 32b is directed to the first output port 6c, and the other part of the hydraulic fluid is directed to the sub-relief valve 81 via the relief port 6f. Further, when the fluid pressure of the hydraulic fluid supplied to the second parallel flow path 32b exceeds the second fluid pressure, even in a case where the fluid pressure of the hydraulic fluid is lower than the first fluid pressure, the sub-relief valve 81 opens, and the hydraulic fluid is directed to the tank 9 via the return passage 33.

**[0035]** As described above, the third fluid control valve 7 has substantially the same configuration as the second fluid control valve 6. Hereinafter, the same names as the corresponding parts in the second fluid control valve 6 and the reference numerals with the leading 6 changed to 7 are attached to each part of the third fluid control valve 7. Specifically, although it is not illustrated, the third fluid control valve 7 includes a body 700 having the same configuration as that of the body 600 of the second fluid control valve 6, and a spool valve body 704 capable of sliding inside a spool hole 702 provided in the body 700. The spool valve body 704 also has the same configuration as that of the spool valve body 604 of the second fluid control valve 6, except that a member constituting the tilt lock valve is not included therein.

**[0036]** On the other hand, although it is not illustrated, the first fluid control valve 5 includes a body 500 having the same configuration as that of the body 600 of the second fluid control valve 6, and a spool valve body 504 capable of sliding in a spool hole 502 provided in the body 500. The spool valve body 504 has the same configuration as that of the spool valve body 604 of the second fluid control valve 6, except that a member constituting the tilt lock valve is not included therein and the third and fourth communication grooves are not included. Further, since the spool valve body 504 does not include the third and fourth communication grooves, as described above, the pilot port 5e and the relief port 5f are always disconnected from each other.

**[0037]** Here, when both the second and third fluid control valves 6 and 7 are disposed at positions other than the neutral position, the second sub-relief passage 34b communicates with the second parallel flow path 32b, and the third sub-relief passage 34c communicates with the third parallel flow path 32c. However, the second sub-relief passage 34b branches on the upstream side of the check valve 605 in the second parallel flow path 32b. Further, the third sub-relief passage 34c branches on the upstream side of the check valve 705 in the third parallel flow path 32c. Therefore, the flow of the hydraulic fluid from the cylinder chamber TS1 or the piston TS2 of the tilt cylinder TS via the second and third sub-relief pas-

sages 34b and 34c to the first or second fluid introduction ports R1a and R1b of the rotary mechanism R or vice versa is suppressed by the check valves 605 and 705. In other words, it is possible to suppress such a flow of the hydraulic fluid, without providing a check valve in the second and third sub-relief passages 34b and 34c.

**[0038]** As described above, according to the present embodiment, the second sub-relief passage 34b branches from the upstream side of the check valve 605 in the second parallel passage 32b, and the third sub-relief passage 34c branches from the upstream side of the check valve 705 in the third parallel passage 32c. Accordingly, the sub-relief passages 34b and 34c do not communicate with the passage reaching the tilt cylinder TS or the rotary mechanism R from the switching valves 6 and 7 inside the switching valves 6 and 7. Even when the tilt cylinder TS and the rotary mechanism R simultaneously operate due to the presence of the check valves 605 and 705, the hydraulic fluid in the tilt cylinder TS does not flow out to the rotary mechanism R via the second and third sub-relief passages 34b and 34c, or vice versa, the hydraulic fluid in the rotary mechanism R does not flow out to the tilt cylinder TS via the second and third sub-relief passages 34b and 34c. Therefore, it is not necessary to additionally provide a check valve in the second and third sub-relief passages 34b and 34c, and thus, it is possible to reduce the number of components and the number of manufacturing man-hours.

**[0039]** The present invention is not limited to the embodiments described above.

**[0040]** For example, in the above-described embodiment, even when any of the second and third switching valves is located at any position other than the neutral position, the hydraulic fluid from the parallel flow path is directed to the sub-relief passage. However, depending on the type of the actuator connected to the switching valve and the type of the operation performed by the actuator, it may be necessary to direct the high-pressure hydraulic fluid. In such a case, an aspect in which the hydraulic fluid from the parallel flow path is directed to the sub-relief passage only when an operation requiring no high-pressure hydraulic fluid is performed may be adopted, and the form can also be easily selected according to the present application.

**[0041]** In addition, various modifications may be made within the scope that does not impair the gist of the present invention.

Reference Signs List

**[0042]**

|     |                             |
|-----|-----------------------------|
| C   | Fluid control device        |
| 23  | Main-relief flow path       |
| 24  | Main-relief valve           |
| 31  | High-pressure flow path     |
| 32a | (First) parallel flow path  |
| 32b | (Second) parallel flow path |

|               |  |
|---------------|--|
| 32c           | (Third) parallel flow path                   |
| 33            | Return flow path                             |
| 34a           | (First) sub-relief flow path                 |
| 34b           | (Second) sub-relief flow path                |
| 5 34c         | (Third) sub-relief flow path                 |
| 5             | Switching valve (first fluid control valve)  |
| 6             | Switching valve (second fluid control valve) |
| 10 7          | Switching valve (third fluid control valve)  |
| 505, 605, 705 | Check valve                                  |
| 81            | Sub-relief valve                             |

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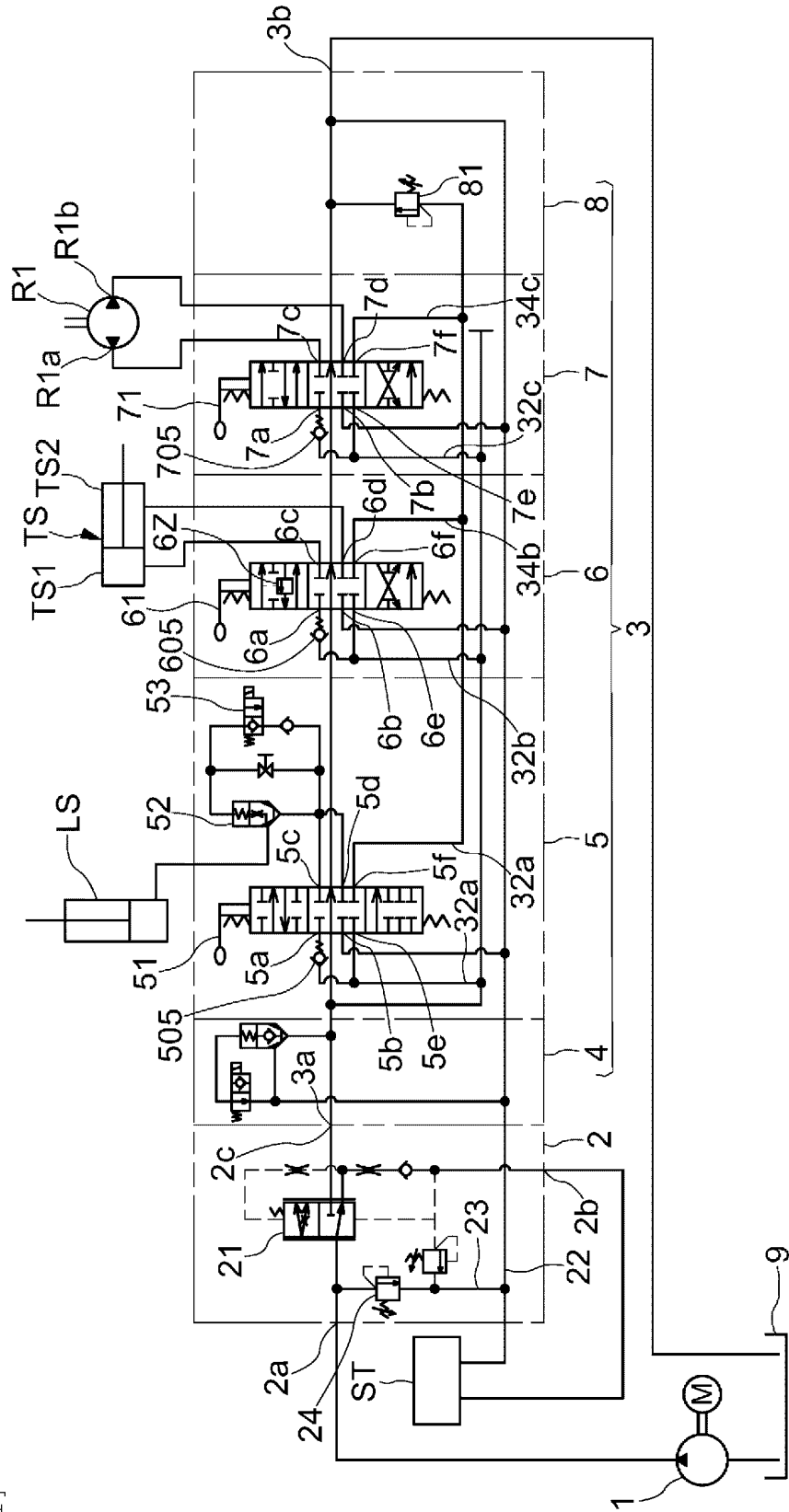
**Claims**

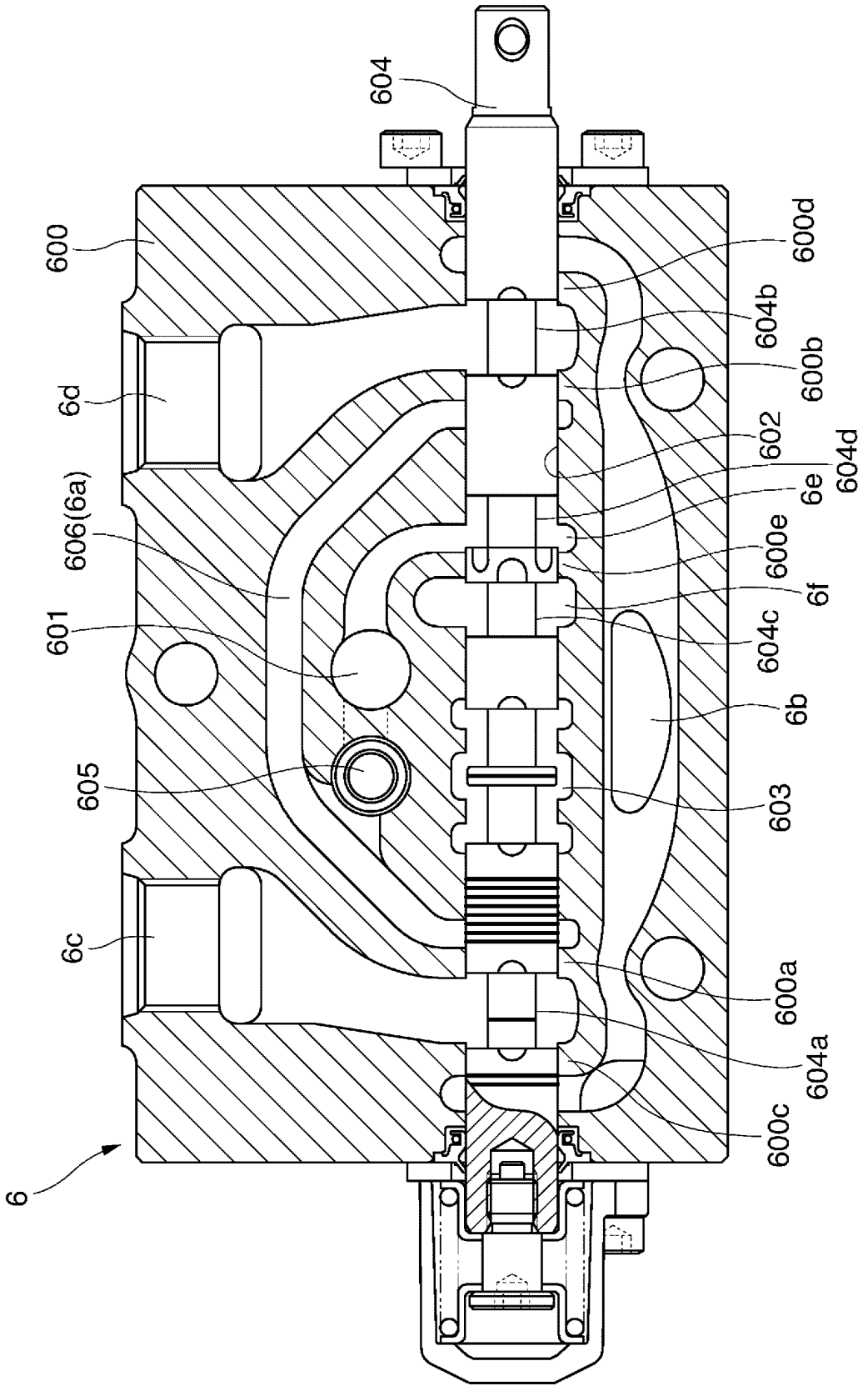
1. A fluid control device comprising:

- 20 a plurality of switching valves;
- a high-pressure flow path which receives supply of high-pressure hydraulic fluid from a hydraulic pressure supply source, and passes through the plurality of switching valves in a neutral state;
- 25 a parallel flow path which branches from the high-pressure flow path to direct the hydraulic fluid to each of the switching valves;
- a return flow path which receives and directs the hydraulic fluid having passed through all the switching valves via the high-pressure flow path and the hydraulic fluid discharged from each switching valve to a tank;
- 30 a main-relief passage through which a part between the hydraulic pressure supply source and the switching valve located on a most upstream side communicates with the return flow path;
- 35 a main-relief valve which is provided in the main-relief passage and opens when the fluid pressure of the high-pressure flow path exceeds a predetermined first fluid pressure;
- 40 a sub-relief passage which branches from the parallel passage, reaches the switching valve, and communicates with the tank when the switching valve is in a predetermined state other than the neutral state;
- 45 a sub-relief valve which is provided in the sub-relief passage, and opens when the fluid pressure of the parallel flow path exceeds a second fluid pressure lower than the first fluid pressure; and
- 50 a check valve which suppresses the flow of hydraulic fluid toward a hydraulic pressure supply source provided between the branch with the sub-relief passage and the switching valve in the parallel passage.

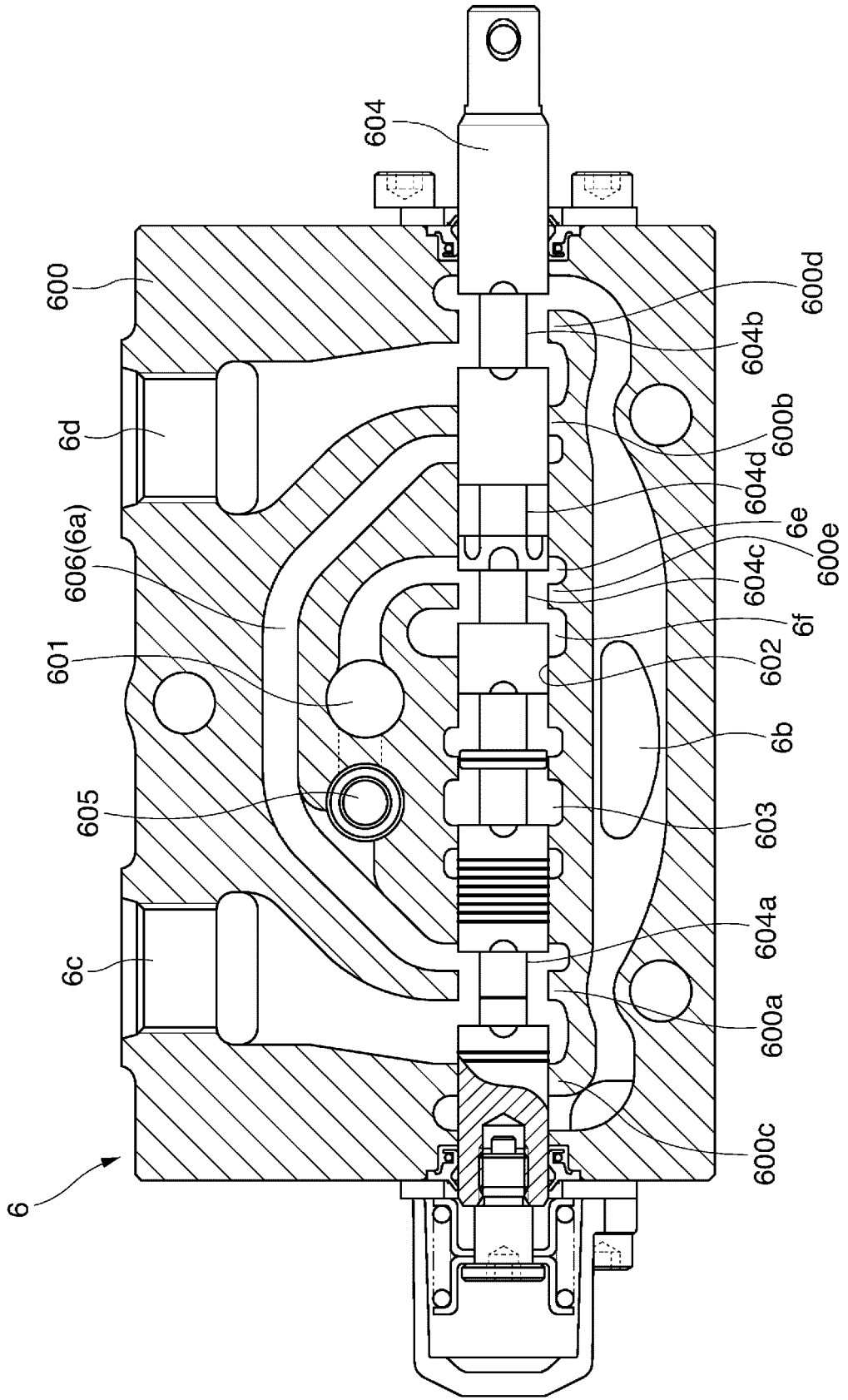
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[FIG. 1]





[FIG. 2]



[FIG. 3]



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/069437

|    |  |  |
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| 5  | A. CLASSIFICATION OF SUBJECT MATTER<br><i>F15B11/16(2006.01) i</i>   |  |
|    | According to International Patent Classification (IPC) or to both national classification and IPC  |  |
| 10 | B. FIELDS SEARCHED   |  |
|    | Minimum documentation searched (classification system followed by classification symbols)<br>F15B11/16   |  |
| 15 | Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched<br>Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2015<br>Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015  |  |
|    | Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)   |  |
| 20 | C. DOCUMENTS CONSIDERED TO BE RELEVANT   |  |
|    | Category*  | Citation of document, with indication, where appropriate, of the relevant passages   |
| 25 | A  | JP 2007-155109 A (Kayaba Industry Co., Ltd.),<br>21 June 2007 (21.06.2007),<br>paragraphs [0002] to [0015], [0025], [0026],<br>[0032] to [0049]; fig. 1, 3<br>(Family: none)   |
| 30 | A  | JP 11-315803 A (Kayaba Industry Co., Ltd.),<br>16 November 1999 (16.11.1999),<br>paragraphs [0042] to [0043]; fig. 1<br>(Family: none)   |
| 35 | A  | US 2003/0115864 A1 (Roger D.MICKELSON),<br>26 June 2003 (26.06.2003),<br>paragraphs [0014] to [0020]; fig. 1<br>(Family: none)   |
| 40 | <input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.  |  |
| 45 | * Special categories of cited documents:<br>"A" document defining the general state of the art which is not considered to be of particular relevance<br>"E" earlier application or patent but published on or after the international filing date<br>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)<br>"O" document referring to an oral disclosure, use, exhibition or other means<br>"P" document published prior to the international filing date but later than the priority date claimed | "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention<br>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone<br>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art<br>"&" document member of the same patent family |
| 50 | Date of the actual completion of the international search<br>15 September 2015 (15.09.15)  | Date of mailing of the international search report<br>06 October 2015 (06.10.15)   |
| 55 | Name and mailing address of the ISA/<br>Japan Patent Office<br>3-4-3, Kasumigaseki, Chiyoda-ku,<br>Tokyo 100-8915, Japan   | Authorized officer<br><br>Telephone No.  |

Form PCT/ISA/210 (second sheet) (July 2009)

**REFERENCES CITED IN THE DESCRIPTION**

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- JP 2007239992 A [0006]